

NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2021-2022

Direct studies of TeraHertz emission generated from phase-matched frequency down-conversion in new nonlinear crystals

General Scope : The scope of this internship is to determine the potentiality of eight nonlinear crystals for generating a coherent and continuously tuneable Terahertz (THz) light. Such an emission is of prime importance for many applications as spectroscopy, biomedical and imaging for example. Our interest is in the frequency range 0,1 - 20 THz corresponding to the wavelength range 3000 - 15 μm .

Research topic and facilities available : The eight selected nonlinear crystals belong to uniaxial or biaxial optical classes and their optical properties are well known in their Mid-infrared (MIR) transparency range. We aim to generate second-order frequency down-conversion processes under birefringent phase-matching (BPM) conditions in these crystals of two incoming beams emitting very close wavelengths located in their MIR transparency range. We will take advantage of our recent calculations that provided a new database for THz emission in all these nonlinear crystals [1].

We will directly generate a continuously tuneable Thz light by using difference frequency generation (DFG) between two incoming monochromatic and tuneable wavelengths interacting collinearly in each nonlinear crystal. They will be provided by a commercial source emitting pulses in the picosecond regime. We will also consider what is also called Optical Rectification between the two Fourier components of the same single pulse of a commercial tuneable femtosecond source. All incoming beams will propagate at normal incidence on the input face of each nonlinear crystal that has been shaped as an oriented slab polished to optical quality. The orientation of their linear polarization will be adjusted by using achromatic half-wave plates. They will be removed after the sample to record the Thz emitted light only using a bolometer detector.

[1] Cyril Bernerd, Patricia Segonds, Jérôme Debray, Jean-François Roux, Emilie Hérault, et al.. Evaluation of eight nonlinear crystals for phase-matched Terahertz second-order difference-frequency generation at room temperature. *Optical Materials Express*, OSA pub, 2020, 10 (2), pp.561. ([10.1364/OME.383548](https://doi.org/10.1364/OME.383548)). ([hal-02450500](https://hal.archives-ouvertes.fr/hal-02450500))

Possible collaboration and networking : All the studied nonlinear crystals were provided thanks to many collaborations with leader groups in crystal growth over the world as BAE Systems, Shandong & Tianjin Universities, Kuban State University, Riken, Chimie ParisTech.

Application to a PhD position is not requested

Required skills: A background in laser optics and non-linear optics will be appreciated.

Starting date: starting from February 2021

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